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An Assessment of the Ambient Air Quality in the Nose Creek District of Calgary

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Air Quality Control Branch

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An Assessment of the Ambient
Air Quality in the Nose Creek
District of Calgary

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August, 1980 to February, 1981

prepared by:

Air Quality Control Branch
Pollution Control Division
Alberta Environment

Edmonton, Alberta

August, 1984

Synopsis

This report summarizes and analyzes the results of the ambient air monitoring survey carried out by the Air Quality Control Branch, Pollution Control Division, Alberta Environment in the Nose Creek area of Calgary from August, 1980 to February, 1981. The survey was conducted in response to a concern expressed to the Department about the quality of the air in the area. The continuous monitoring for soiling index (COH), oxides of nitrogen (NO_x), nitric oxide (NO), nitrogen dioxide (NO_2), sulphur dioxide (SO_2), ozone (O_3), total hydrocarbons (THC), and carbon monoxide (CO) resulted in a number of findings:

1. All pollutants monitored, with the exception of carbon monoxide and ozone, were 100% in compliance with the Alberta Clean Air (Maximum Levels) Regulations at Calgary Mobile Monitoring Unit (CMMU). Ozone showed 100% compliance with the 0.080 ppm 1-hour Regulation, and 91.0% compliance with the 0.025 ppm 24-hour Regulation. Carbon monoxide showed 98.5% compliance with the 13 ppm 1-hour CO Regulation, and 89.6% compliance with the 5 ppm 8-hour CO Regulation.
2. The air quality index (IQUA) recorded at CMMU located in the Nose Creek area was in the "good" air quality range 85.5% of the monitoring period.
3. The average IQUA reading at CMMU was lower than at the Calgary Downtown Monitoring Unit, (CDMU), but higher than the average IQUA reading at the Calgary Residential Monitoring Unit (CRMU). CMMU registered the highest maximum index reading of the three stations.

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1. Introduction

In response to a concern expressed to the Department about the quality of the air in the Nose Creek district of Calgary, the Air Quality Control Branch of the Pollution Control Division of Alberta Environment carried out an air monitoring survey in the area from August 1, 1980 to February 28, 1981. The Calgary Mobile Monitoring Unit, (CMMU), equipped to monitor soiling index (COH), oxides of nitrogen (NO_x), nitric oxide (NO), nitrogen dioxide (NO_2), sulphur dioxide, (SO_2), ozone (O_3), total hydrocarbons (THC), carbon monoxide (CO), and wind speed and direction, was located at 38th Avenue and 4th Street N.E., Calgary (Figure 1). Assessment of the air quality was based upon a comparison of the monitored data with the Alberta Clean Air (Maximum Levels) Regulations.

The sections that follow include a summary and analysis of the data, and conclusions drawn from that analysis. Comparisons are also made between the data obtained at the monitoring trailer and data obtained at the Calgary Downtown Monitoring Unit, (CDMU), and Calgary Residential Monitoring Unit, (CRMU). Data for each parameter monitored at CMMU are presented in the form of period summaries containing the arithmetic mean, maximum 1-hour and 24-hour concentrations, and the percentage of time the readings were in compliance with the Regulations. Data for ozone and carbon monoxide are also presented pictorially in the form of wind and pollution roses (Figures 7 and 8) for the Nose Creek (CMMU) station.

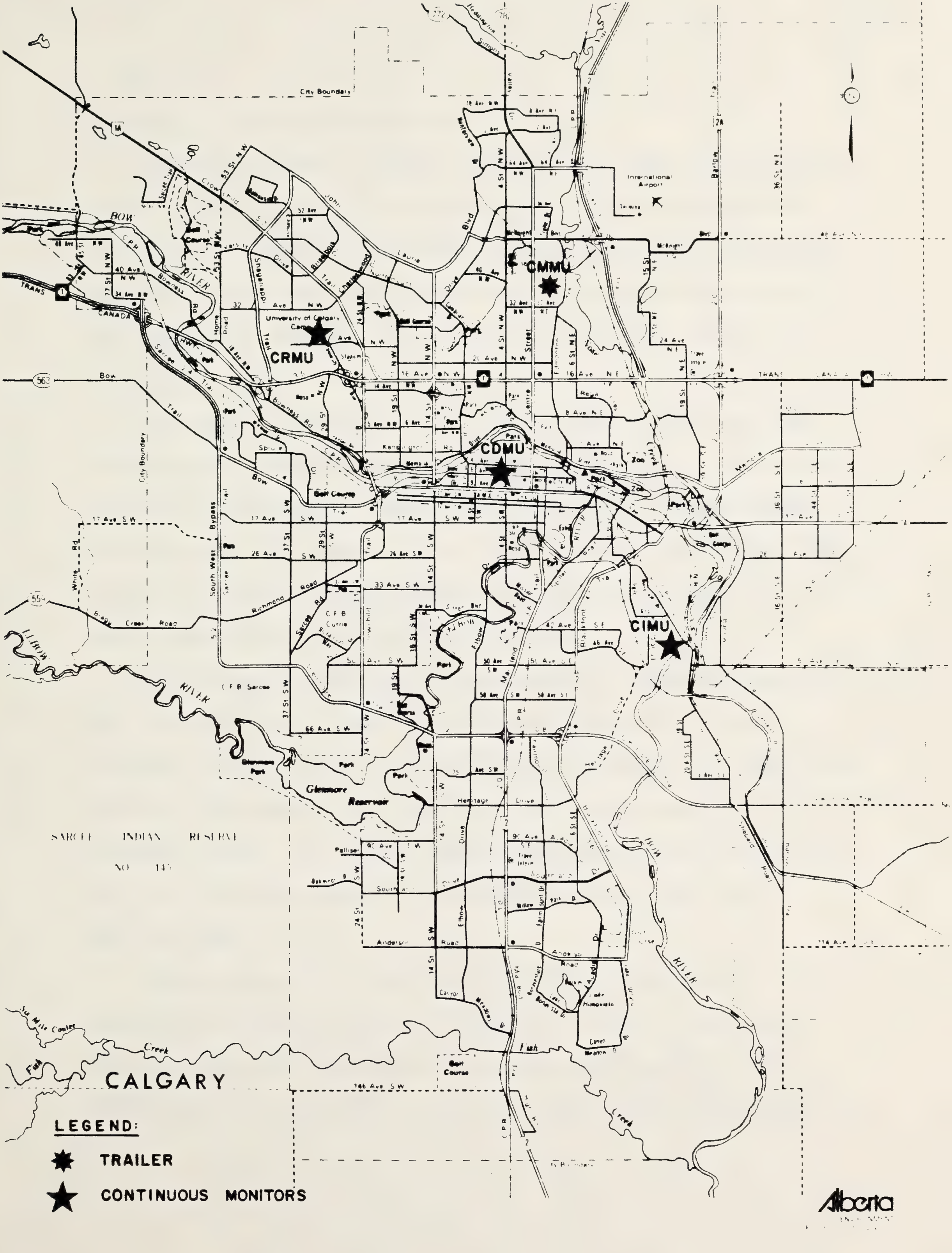


FIGURE I. MAP SHOWING LOCATION OF AIR MONITORING TRAILER

2. Results

2.1 Index of the Quality of the Air

The index is based on ambient readings for sulphur dioxide, ozone, carbon monoxide, suspended particulate matter, and nitrogen dioxide. Each pollutant reading is converted to an IQUA number, and the highest number becomes the index for the station. A general breakdown of the IQUA number is as follows: 0 - 25 good air quality, 26 - 50 fair air quality, 51 - 100 poor air quality, 101+ very poor air quality.

An examination of the air quality index readings for Nose Creek during the period August, 1980 to February, 1981 (Table 1), shows that the monthly average Index readings were in the "good" range, but that there were some peak readings in the "poor" and "very poor" range. The air quality index at the Nose Creek station was in the "good" air quality range 85.5% of the monitoring period.

When the Air Quality Index for Nose Creek is compared to those of CRMU and CDMU (Table 1), some differences are noticeable. Calgary Residential Monitoring Unit, located near the University of Calgary, had an average IQUA number lower than Nose Creek's average number for the monitoring period. The Calgary Downtown Monitoring Unit, on the other hand, had the highest monthly average IQUA readings of the three stations (Table 1).

The average hourly air quality index for all three stations during the monitoring period is given in Figures 2, 3, and 4. Once again, CDMU (Figure 4), had the highest average hourly air quality index, followed by Nose Creek (CMMU), (Figure 2), and finally, CRMU (Figure 3).

TABLE 1

SUMMARY OF IQUA MAXIMUM AND AVERAGE READINGS
CMMU, CRMU, CDMU, AUGUST, 1980 - FEBRUARY, 1981

	CMMU		CRMU		CDMU	
Date	Average Index Reading	Maximum Index Reading	Average Index Reading	Maximum Index Reading	Average Index Reading	Maximum Index Reading
AUGUST, 1980	13	30	13	29	15	33
SEPTEMBER, 1980	13	38	13	57+	19	45
OCTOBER, 1980	9	56	12	52	22	51
NOVEMBER, 1980	21	109	13	38	24	105
DECEMBER, 1980	18	171*	12	50	21	113*
JANUARY, 1981	21	53	13	55	25	73
FEBRUARY, 1981	16	65	13	50	23	80
AUGUST, 1980 - FEBRUARY, 1981	16	171	13	57	21	113

* Resulting from an 8-hour CO reading

+ Resulting from a 1-hour O_3 reading

FIGURE 2. INDEX OF THE QUALITY OF THE AIR-NOSE CREEK (CMMU) AUGUST, 1980-FEBRUARY, 1981

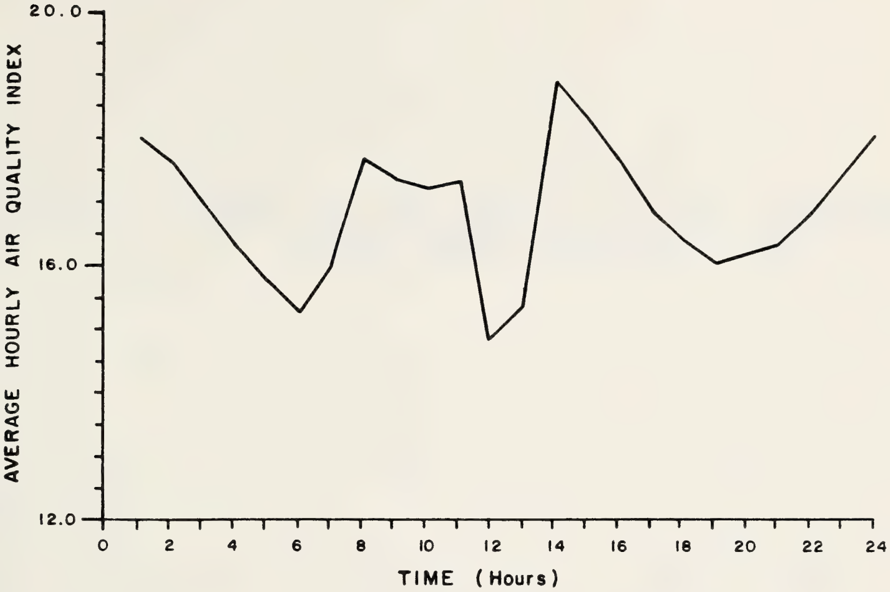


FIGURE 3. INDEX OF THE QUALITY OF THE AIR-CRMU AUGUST, 1980-FEBRUARY, 1981

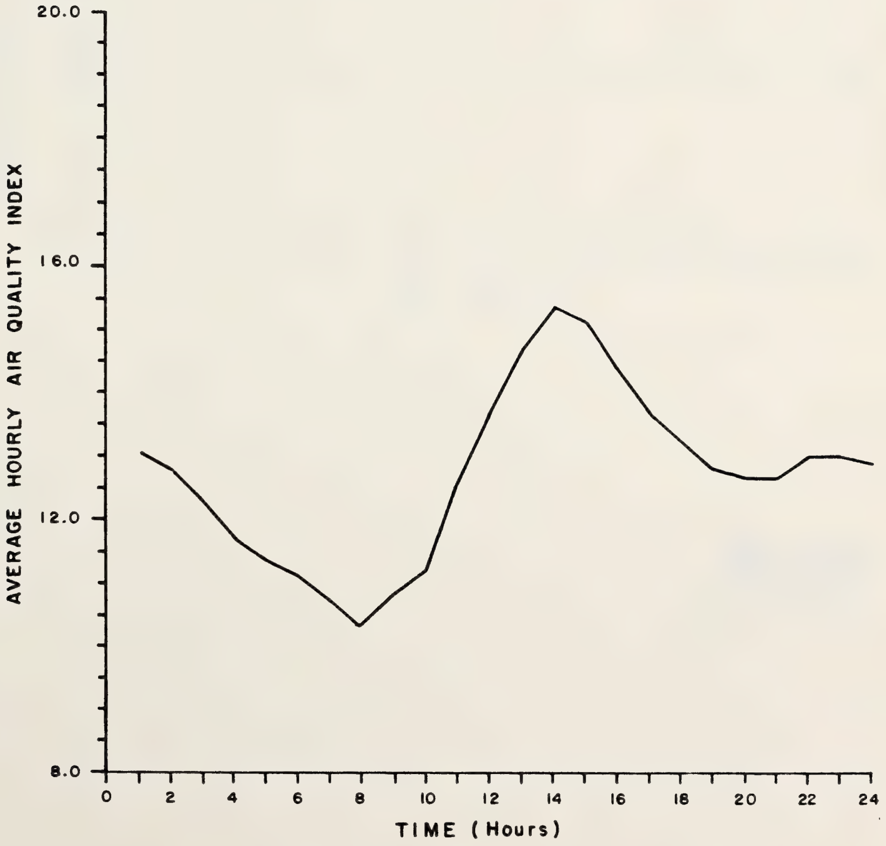
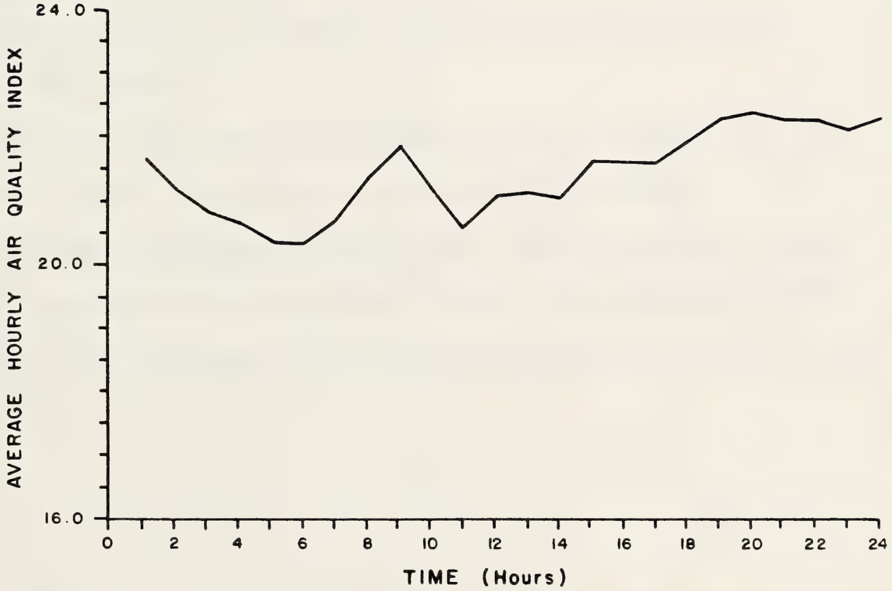


FIGURE 4. INDEX OF THE QUALITY OF THE AIR-CDMU
AUGUST, 1980-FEBRUARY, 1981



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2.2 General Results

Tables 2 to 10 summarize the data collected during the period of the monitoring survey. An examination of these tables reveals that at the Nose Creek monitoring location Coefficient of Haze (COH), nitrogen dioxide (NO_2), and sulphur dioxide (SO_2), were all 100% in compliance with the Alberta Clean Air (Maximum Levels) Regulations and/or guidelines. One-hour ozone readings were also 100% in compliance with the Regulations. The 24-hour ozone readings were in compliance 91.0% of the monitoring period. The peak 24-hour ozone reading occurred in August, 1980 (Table 7).

There were also some carbon monoxide readings in excess of the Regulation levels. The one-hour carbon monoxide readings were in compliance 98.5% of the monitoring period, and the eight-hour carbon monoxide readings were in compliance 89.6% of the monitoring period. Peak hourly and eight-hour CO readings both occurred in December, 1980 (Table 8).

TABLE 2
SUMMARY OF COEFFICIENT OF HAZE (COH) READINGS - NOSE CREEK, CALGARY

MONITORING PERIOD	AVERAGE CONCENTRATION (COH)	MAXIMUM READINGS (COH)		% OF TIME INSTRUMENT OPERATIONAL	PERCENTAGE OF READINGS IN COMPLIANCE WITH GUIDELINE*
		1 hour	24 hour		
AUGUST, 1980	0.12	1.2	0.30	96.77	100
SEPTEMBER, 1980	0.14	1.5	0.47	98.19	100
OCTOBER, 1980	0.25	2.0	0.61	99.46	100
NOVEMBER, 1980	0.33	4.1	1.14	100.00	100
DECEMBER, 1980	0.22	2.7	1.02	97.31	100
JANUARY, 1981	0.30	2.1	0.73	100.00	100
FEBRUARY, 1981	0.24	2.6	0.89	93.15	100
AUGUST, 1980 - FEBRUARY, 1981	0.22	4.1	1.14	97.89	100

* Alberta Environment Guideline requires that no more than 10% of the readings should be greater than 1.0 COH (Coefficient of Haze).

TABLE 3
SUMMARY OF NITROGEN DIOXIDE (NO_2) READINGS - NOSE CREEK, CALGARY

MONITORING PERIOD	AVERAGE CONCENTRATION (PPM)	MAXIMUM READINGS (PPM)		% OF TIME INSTRUMENT OPERATIONAL	% COMPLIANCE WITH REGULATION*	
		1 hour	24 hour		1 hour	24 hour
AUGUST, 1980	0.02	0.09	0.03	74.33	100	100
SEPTEMBER, 1980	0.02	0.08	0.03	93.33	100	100
OCTOBER, 1980	0.02	0.09	0.04	97.98	100	100
NOVEMBER, 1980	0.03	0.17	0.06	98.89	100	100
DECEMBER, 1980	0.03	0.16	0.06	99.33	100	100
JANUARY, 1981	0.02	0.14	0.04	99.19	100	100
FEBRUARY, 1981	0.02	0.10	0.05	99.26	100	100
AUGUST, 1980 - FEBRUARY, 1981	0.02	0.17	0.06	94.53	100	100

* Alberta Clean Air (Maximum Levels) Regulations; 1 hour - 0.21 ppm, 24 hour - 0.11 ppm.

TABLE 4
SUMMARY OF OXIDES OF NITROGEN (NO_x) READINGS - NOSE CREEK, CALGARY

MONITORING PERIOD	AVERAGE CONCENTRATION (PPM)	MAXIMUM READINGS (PPM) 1 hour	MAXIMUM READINGS (PPM) 24 hour	% OF TIME INSTRUMENT OPERATIONAL	% COMPLIANCE WITH REGULATION 1 hour	% COMPLIANCE WITH REGULATION 24 hour
AUGUST, 1980	0.03	0.33	0.07	74.06	NO REGULATION	
SEPTEMBER, 1980	0.04	0.31	0.13	93.33	NO REGULATION	
OCTOBER, 1980	0.07	0.55	0.16	97.98	NO REGULATION	
NOVEMBER, 1980	0.10	0.90	0.32	98.89	NO REGULATION	
DECEMBER, 1980	0.09	1.00	0.39	99.33	NO REGULATION	
JANUARY, 1981	0.11	0.64	0.23	99.19	NO REGULATION	
FEBRUARY, 1981	0.07	0.68	0.26	99.26	NO REGULATION	
AUGUST, 1980 - FEBRUARY, 1981	0.07	1.00	0.39	94.49	NO REGULATION	

TABLE 5
SUMMARY OF NITRIC OXIDE (NO) READINGS - NOSE CREEK, CALGARY

MONITORING PERIOD	AVERAGE CONCENTRATION (PPM)	MAXIMUM READINGS (PPM)		% OF TIME INSTRUMENT OPERATIONAL	% COMPLIANCE WITH REGULATION	
		1 hour	24 hour		1 hour	24 hour
AUGUST, 1980	0.02	0.31	0.05	74.06	NO REGULATION	
SEPTEMBER, 1980	0.02	0.28	0.11	93.33	NO REGULATION	
OCTOBER, 1980	0.05	0.50	0.12	97.98	NO REGULATION	
NOVEMBER, 1980	0.08	0.82	0.26	98.89	NO REGULATION	
DECEMBER, 1980	0.06	0.90	0.33	99.33	NO REGULATION	
JANUARY, 1981	0.09	0.57	0.20	99.19	NO REGULATION	
FEBRUARY, 1981	0.05	0.58	0.20	99.26	NO REGULATION	
AUGUST, 1980 - FEBRUARY, 1981	0.05	0.90	0.33	94.49	NO REGULATION	

TABLE 6
SUMMARY OF SULPHUR DIOXIDE (SO_2) READINGS - NOSE CREEK, CALGARY

MONITORING PERIOD	AVERAGE CONCENTRATION (PPM)	MAXIMUM READINGS (PPM) 1 hour	MAXIMUM READINGS (PPM) 24 hour	% OF TIME INSTRUMENT OPERATIONAL	% COMPLIANCE WITH REGULATION* 1 hour	% COMPLIANCE WITH REGULATION* 24 hour
AUGUST, 1980	0.00	0.01	0.00	96.24	100	100
SEPTEMBER, 1980	0.00	0.01	0.01	98.75	100	100
OCTOBER, 1980	0.00	0.01	0.00	98.12	100	100
NOVEMBER, 1980	0.00	0.02	0.01	97.22	100	100
DECEMBER, 1980	0.00	0.02	0.00	99.46	100	100
JANUARY, 1981	0.00	0.07	0.02	99.19	100	100
FEBRUARY, 1981	0.00	0.02	0.01	99.55	100	100
AUGUST, 1980 - FEBRUARY, 1981	0.00	0.07	0.02	98.34	100	100

* Alberta Clean Air (Maximum Levels) Regulations; 1 hour 0.17 ppm, 24 hour - 0.06 ppm.

TABLE 7
SUMMARY OF OZONE (O_3) READINGS - NOSE CREEK, CALGARY

MONITORING PERIOD	AVERAGE CONCENTRATION (PPM)	MAXIMUM READINGS (PPM)		% OF TIME INSTRUMENT OPERATIONAL	% COMPLIANCE WITH REGULATION*	
		1 hour	24 hour		1 hour	24 hour
AUGUST, 1980	0.020	0.060	0.037	97.72	100	73.6
SEPTEMBER, 1980	0.015	0.055	0.029	99.17	100	89.9
OCTOBER, 1980	0.012	0.040	0.028	99.33	100	93.5
NOVEMBER, 1980	0.013	0.045	0.027	99.72	100	96.7
DECEMBER, 1980	0.013	0.040	0.030	99.73	100	96.8
JANUARY, 1981	0.008	0.035	0.026	99.73	100	93.5
FEBRUARY, 1981	0.012	0.035	0.026	99.70	100	92.8
AUGUST, 1980 - FEBRUARY, 1981	0.013	0.060	0.037	99.29	100	91.0

* Alberta Clean Air (Maximum Levels) Regulations; 1 hour - 0.080 ppm, 24 hour - 0.025 ppm.

TABLE 8
SUMMARY OF CARBON MONOXIDE (CO) READINGS - NOSE CREEK, CALGARY

MONITORING PERIOD	AVERAGE CONCENTRATION (PPM)	MAXIMUM READINGS (PPM)		% OF TIME INSTRUMENT OPERATIONAL	% COMPLIANCE WITH REGULATION*	
		1 hour	8 hour		1 hour	8 hour
AUGUST, 1980	1.48	7.50	2.88	11.16+	100	100
SEPTEMBER, 1980	1.98	15.0	6.88	99.03	99.7	95.5
OCTOBER, 1980	2.40	17.5	5.88	99.73	99.6	91.4
NOVEMBER, 1980	2.77	28.5	16.88	100.00	97.2	83.3
DECEMBER, 1980	2.36	29.0	24.63	100.00	97.0	88.2
JANUARY, 1981	3.31	25.0	13.00	99.87	96.6	79.5
FEBRUARY, 1981	2.30	16.5	11.00	99.40	99.1	89.2
AUGUST, 1980 - FEBRUARY, 1981	2.37	29.0	24.63	86.73	98.5	89.6

* Alberta Clean Air (Maximum Levels) Regulations; 1 hour - 13 ppm, 8 hour - 5 ppm.

+ An operational time of less than 75% means that monthly averages may not be representative.

TABLE 9
SUMMARY OF TOTAL HYDROCARBON (THC) READINGS - NOSE CREEK, CALGARY

MONITORING PERIOD	AVERAGE CONCENTRATION (PPM)	MAXIMUM READINGS (PPM)		% OF TIME INSTRUMENT OPERATIONAL	% COMPLIANCE WITH REGULATION	
		1 hour	24 hour		1 hour	24 hour
AUGUST, 1980	1.89	3.6	2.38	94.76	NO REGULATION	
SEPTEMBER, 1980	1.99	4.9	2.57	96.94	NO REGULATION	
OCTOBER, 1980	2.19	5.2	2.82	99.87	NO REGULATION	
NOVEMBER, 1980	2.30	9.5	3.98	100.00	NO REGULATION	
DECEMBER, 1980	2.25	8.7	3.99	100.00	NO REGULATION	
JANUARY, 1981	2.49	6.2	3.40	100.00	NO REGULATION	
FEBRUARY, 1981	2.16	5.9	3.38	100.00	NO REGULATION	
AUGUST, 1980 - FEBRUARY, 1981	2.18	9.5	3.99	98.78	NO REGULATION	

TABLE 10
FREQUENCY DISTRIBUTION OF WIND - NOSE CREEK, CALGARY

MONITORING PERIOD	CALM	N	NE	E	SE	S	SW	W	NW	PERCENT OF INSTRUMENT DOWN TIME
AUGUST, 1980	21.24	15.46	2.15	2.82	10.62	4.84	4.84	11.96	22.18	3.89
SEPTEMBER, 1980	16.81	14.72	3.19	3.89	12.36	7.50	9.72	19.03	11.67	1.11
OCTOBER, 1980	25.27	7.66	2.96	1.08	10.89	2.82	5.11	24.46	16.26	3.49
NOVEMBER, 1980	22.36	9.58	1.25	0.28	3.19	4.86	10.56	34.86	7.08	5.98
DECEMBER, 1980	17.74	21.77	6.45	2.82	10.89	7.12	7.26	20.70	5.24	0.01
JANUARY, 1981	15.05	13.31	6.85	2.69	5.24	13.58	9.41	10.08	23.79	0.00
FEBRUARY, 1981	16.22	8.48	5.21	4.76	11.90	8.63	9.08	24.40	11.31	0.01
AUGUST, 1980-FEBRUARY, 1981	19.28	13.06	4.00	2.59	9.27	7.03	7.96	20.67	14.01	2.13

3. Data Analysis

Four of the parameters monitored at CMMU are included in this section on data analysis: carbon monoxide, ozone, nitrogen dioxide, and nitric oxide. Both carbon monoxide and ozone concentrations exceeded occasionally the Alberta Clean Air (Maximum Levels) Regulations, and nitric oxide and nitrogen dioxide levels in the atmosphere have an influence on the amount of ozone that will be present in the ambient air.

3.1 Nitric Oxide, Nitrogen Dioxide, and Ozone

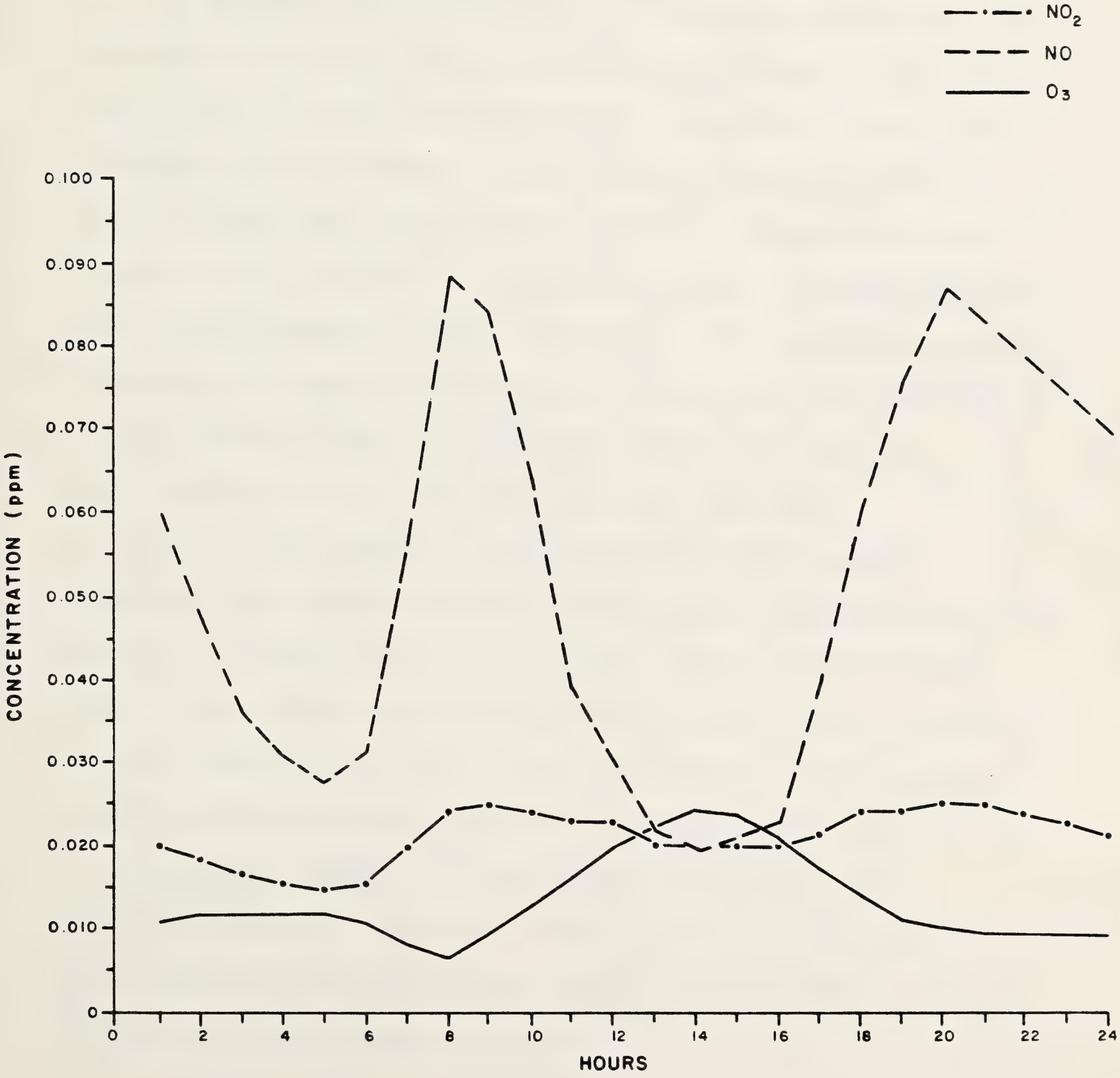
Ambient concentrations of oxides of nitrogen (which include NO and NO_2) result, in part, from vehicle operation. Together with hydrocarbons, oxygen, and sunlight, these pollutants contribute to the photochemical production of ozone in the ambient air. The average diurnal patterns for NO, NO_2, and O_3 at CMMU are shown in Figure 5.

An examination of the patterns shows that for nitric oxide and nitrogen dioxide, levels peak around 0800 to 0900 hours, and begin to increase again later in the day around 1600 hours (peaking between 1900 and 2100 hours). These peaks are related to rush hour traffic periods.

For ozone, a concentration peak occurs at approximately 1400 hours. This ozone peak is a result of photochemical atmospheric reactions involving nitrogen oxides, hydrocarbons, oxygen and solar radiation.

It should be noted that occurrences of ozone concentrations in excess of the Regulations are not unique to the Nose Creek district of Calgary. Most areas of Alberta, for which extensive ozone data are

FIGURE 5. AVERAGE DIURNAL VARIATION OF CONCENTRATION FOR NITRIC OXIDE (NO), NITROGEN DIOXIDE (NO_2), AND OZONE (O_3) AT CMMU, AUGUST, 1980-FEBRUARY, 1981.



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available, have recorded readings in excess of the Regulation levels. Such concentrations result from the photochemical production of ozone as well as from naturally occurring background levels.

3.2 Carbon Monoxide

The average diurnal pattern of carbon monoxide concentration levels recorded at CMMU during the monitoring period is shown in Figure 6. Examination of the data indicates that the occurrence of higher levels of carbon monoxide at CMMU is closely tied to times of rush hour traffic. Levels peak around 0800 to 0900 hours, decrease during the mid-day period, and begin to increase again later in the day around 1600 hours (peaking between 1900 and 2100 hours). This correlation of higher carbon monoxide readings with times of rush-hour traffic is expected, as carbon monoxide is one of the pollutants emitted from vehicles.

3.3 Correlation of Wind with Ozone and Carbon Monoxide

Levels of both ozone and carbon monoxide at CMMU exceeded occasionally the Alberta Clean Air (Maximum Levels) Regulations and are, therefore, included in the section on wind correlation. A review of Table 10 shows that westerly winds predominated during the monitoring period, accounting for 20.67% of total wind activity. Calm conditions were also prevalent during the period, totaling 19.28% of wind activity.

There was a strong correlation between ozone and all wind directions (Figure 7). Over 90% of north, north-east, west, and north-west winds, resulted in ozone readings, while 29.38% of the ozone readings occurred with westerly winds.

FIGURE 6. AVERAGE DIURNAL VARIATION OF CONCENTRATION FOR CARBON MONOXIDE (CO) AT CMMU, AUGUST, 1980-FEBRUARY, 1981.

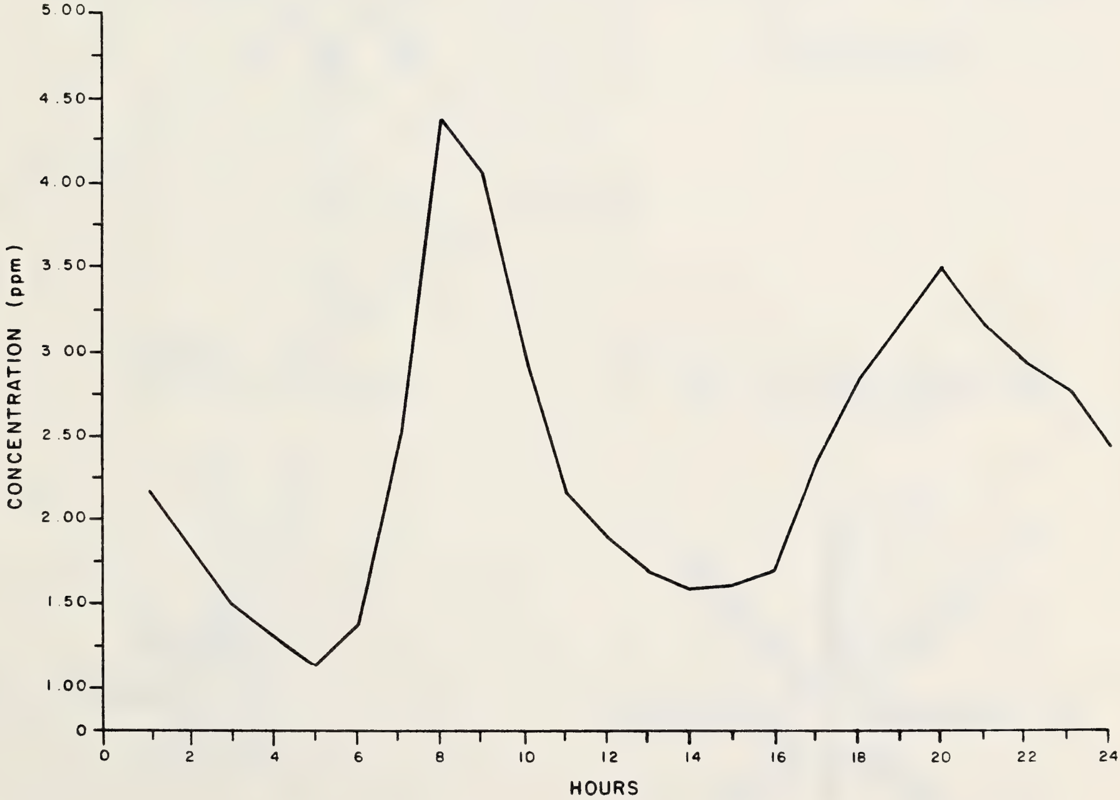

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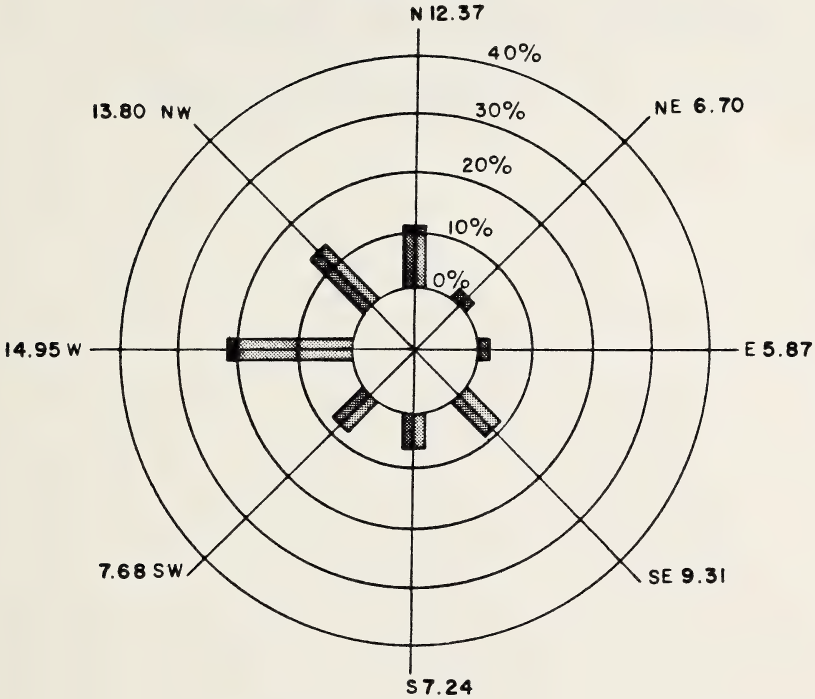
FIGURE 7. CORRELATION OF WINDS WITH OZONE (O_3) READINGS, NOSE CREEK

WIND ROSE

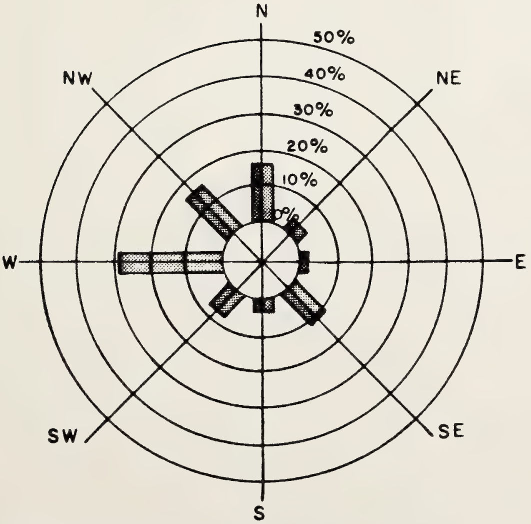


Calm Conditions 19.28%

Average Wind Speed 12.02 Km/h

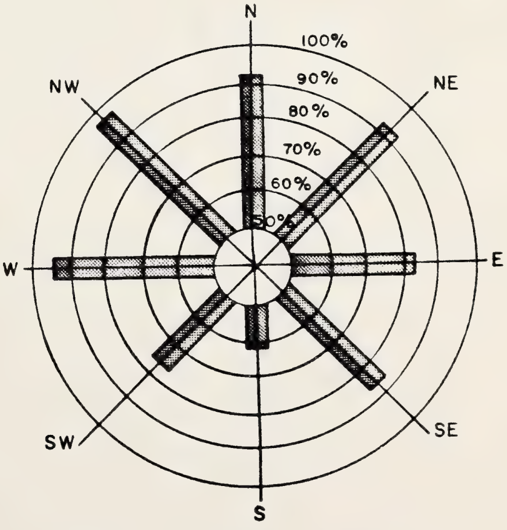
Wind Speeds Are Shown At The Outer Circle

PERCENT OF O_3 READINGS WITH WIND



4.08 % of O_3 Readings Recorded With Calm Conditions

PERCENT OF WINDS RESULTING IN O_3 READINGS



15.32 % of Calm Winds Resulted in O_3 Readings

NOTE: CHANGE IN SCALE TO ACCOMODATE HIGH PERCENTAGE OF O_3 READINGS

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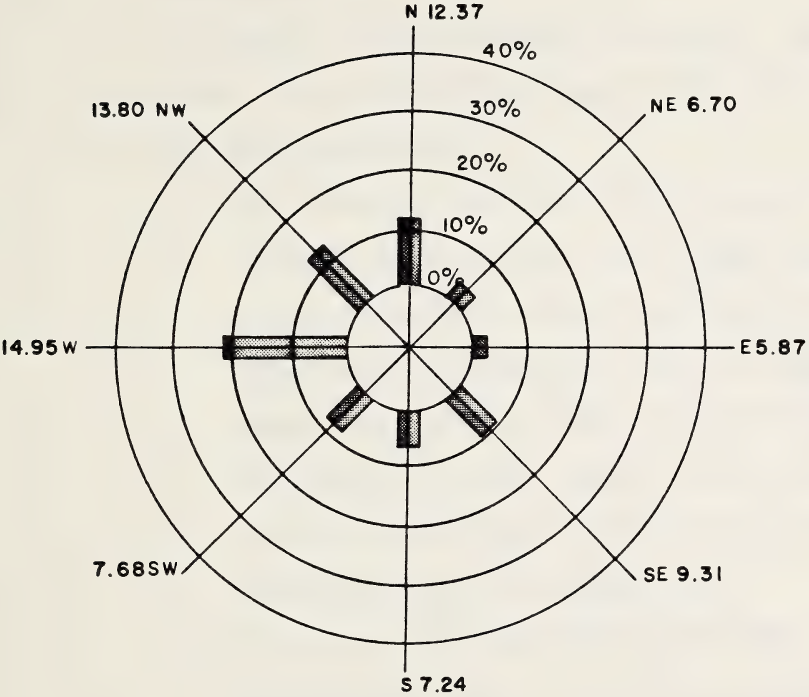
Calm conditions showed the strongest correlation with carbon monoxide (Figure 8). A total of 61.35% of all CO readings occurred with calm conditions, while 56.54% of calm conditions resulted in carbon monoxide readings (Figure 8).

FIGURE 8. CORRELATION OF WINDS WITH CARBON MONOXIDE (CO) READINGS, NOSE CREEK

WIND ROSE



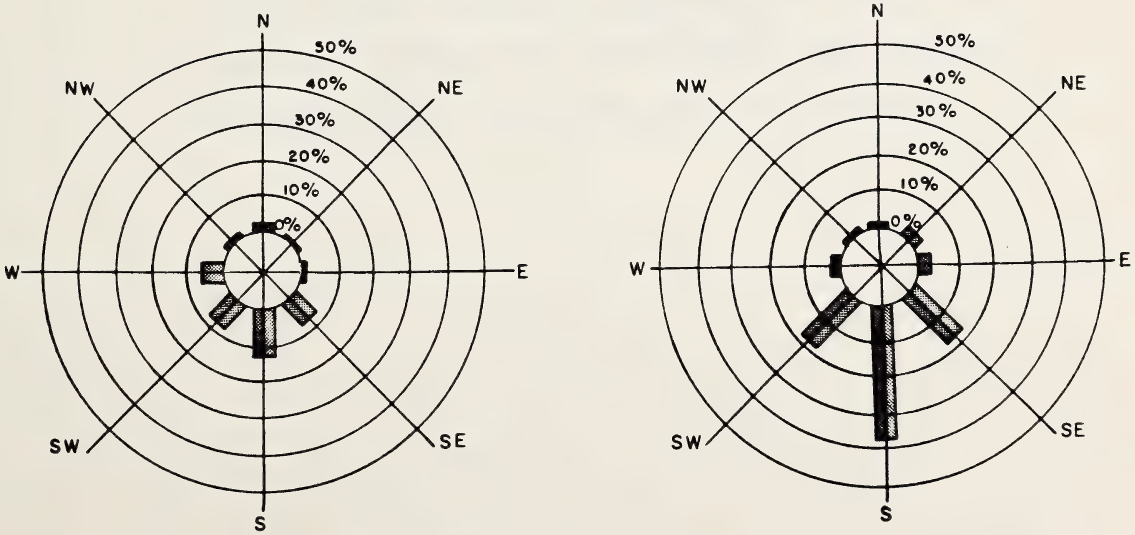
Calm Conditions 19.28 %

Average Wind Speed 12.02 Km/h

Wind Speeds Are Shown At The Outer Circle

PERCENT OF CO READINGS WITH WIND

PERCENT OF WINDS RESULTING IN CO READINGS



61.35 % of CO Readings Recorded With Calm Conditions

56.54 % of Calm Winds Resulted in CO Readings

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4. Conclusions

The results of the continuous monitoring of the ambient air in the Nose Creek area of Calgary from August, 1980 to February, 1981 have led to three main conclusions:

1. All pollutants monitored, with the exception of carbon monoxide and ozone, were 100% in compliance with the Alberta Clean Air (Maximum Levels) Regulations at Nose Creek (CMMU). Ozone showed 100% compliance with the 0.080 ppm 1-hour Regulation, and 91.0% compliance with the 0.025 ppm 24-hour Regulation for ozone. Carbon monoxide showed 98.5% compliance with the 13 ppm 1-hour CO Regulation, and 89.6% compliance with the 5 ppm 8-hour CO Regulation.
2. The air quality index (IQUA) at the Nose Creek station was in the "good" air quality range 85.5% of the monitoring period.
3. The average IQUA reading at CMMU was lower than at the downtown station, (CDMU), but higher than the average IQUA reading at the residential station (CRMU). CMMU registered the highest maximum index reading of the three stations.

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